Historical GOES AMV Reprocessing

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11th Annual Symposium on New Generation Operational Environmental Satellite Systems
Satellite Observations for Climate
Phoenix, Arizona
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Outline

- Motivation for Reprocessing AMVs
- Historical Dataset Reprocessing Methodology
- Example Results and Quality Control
- Summary and Potential Future Plans

Motivation

- Following the recommendations from the 9th and 10th International Winds Workshops and the Coordination Group for Meteorological Satellites (CGMS)
- Complements the AMV reprocessing efforts from JMA and EUMETSAT
- Provides a baseline for future AMV reprocessing with the next generation (GOES-R) algorithms
- New NWP reanalysis efforts are planned (ECMWF, JMA, NASA-GMAO)
- Reprocessed GOES AMVs will be an important data resource for research studies

Motivation

- ECMWF: "*keen interest by ECMWF in the proposed effort*"… "*…we are encouraged by this proposal and strongly support it as a contribution to filling the AMV data gap.*"
- The Global Climate Observing System (GCOS) leadership: "*we can only express the very strongest support of the GCOS programme for your proposed reprocessing, which would meet a longstanding and off-stated need.*"
- JMA: *"The reprocessing of historical GOES AMVs data will surely bring benefits to, and will be appreciated by, the NWP and climate communities. In this context, I wish to express my heartfelt appreciation to your efforts and my cordial welcome for your proposal."*
- UW-Madison/SSEC-CIMSS (AMV re-processors): Has a long history in AMV development going back to FGGE reprocessing in the late 1970's. The SSEC directors sensed the importance of this latest reprocessing effort and provided the support for the first phase.

Processing Details (Data)

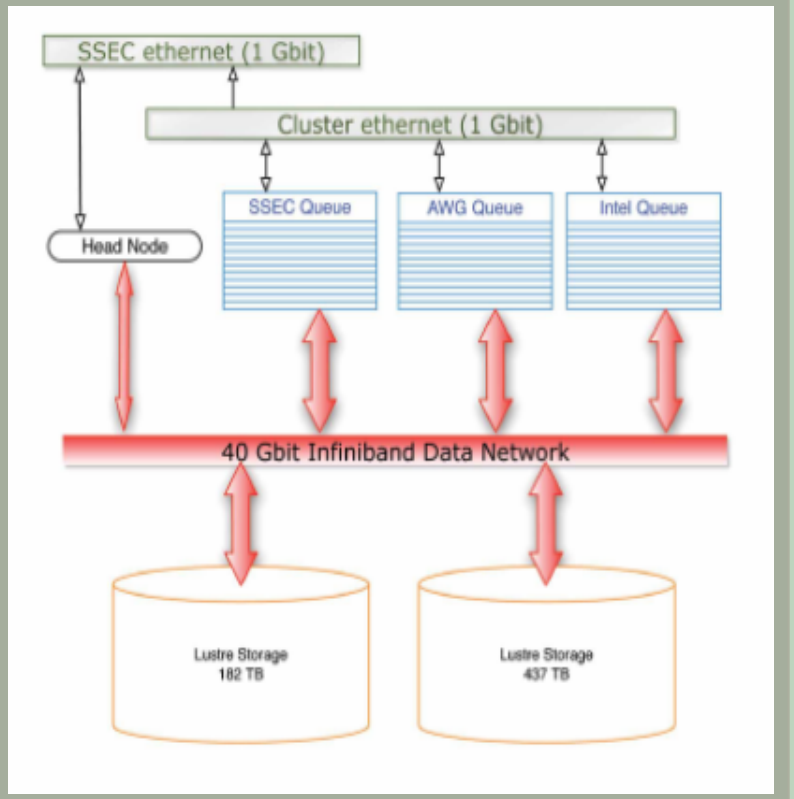
- Period: GOES GVAR Era ->1995 to mid 2013
- Background NWP fields: Interpolated 6-hour analyses from the ERA Interim dataset
- Hourly, near-full-disk datasets using most frequent imager (no sounder) scan triplets available (except no rapid-scans)

  GOES East (1995 – mid 2013)
  - Includes GOES-8/10/12/13/14

  GOES West (1996 – mid 2013)
  - Includes GOES-9/10/11/15
- Channels processed: VIS, LWIR, SWIR, WV
- Entire GOES image archive on-line at UW-SSEC

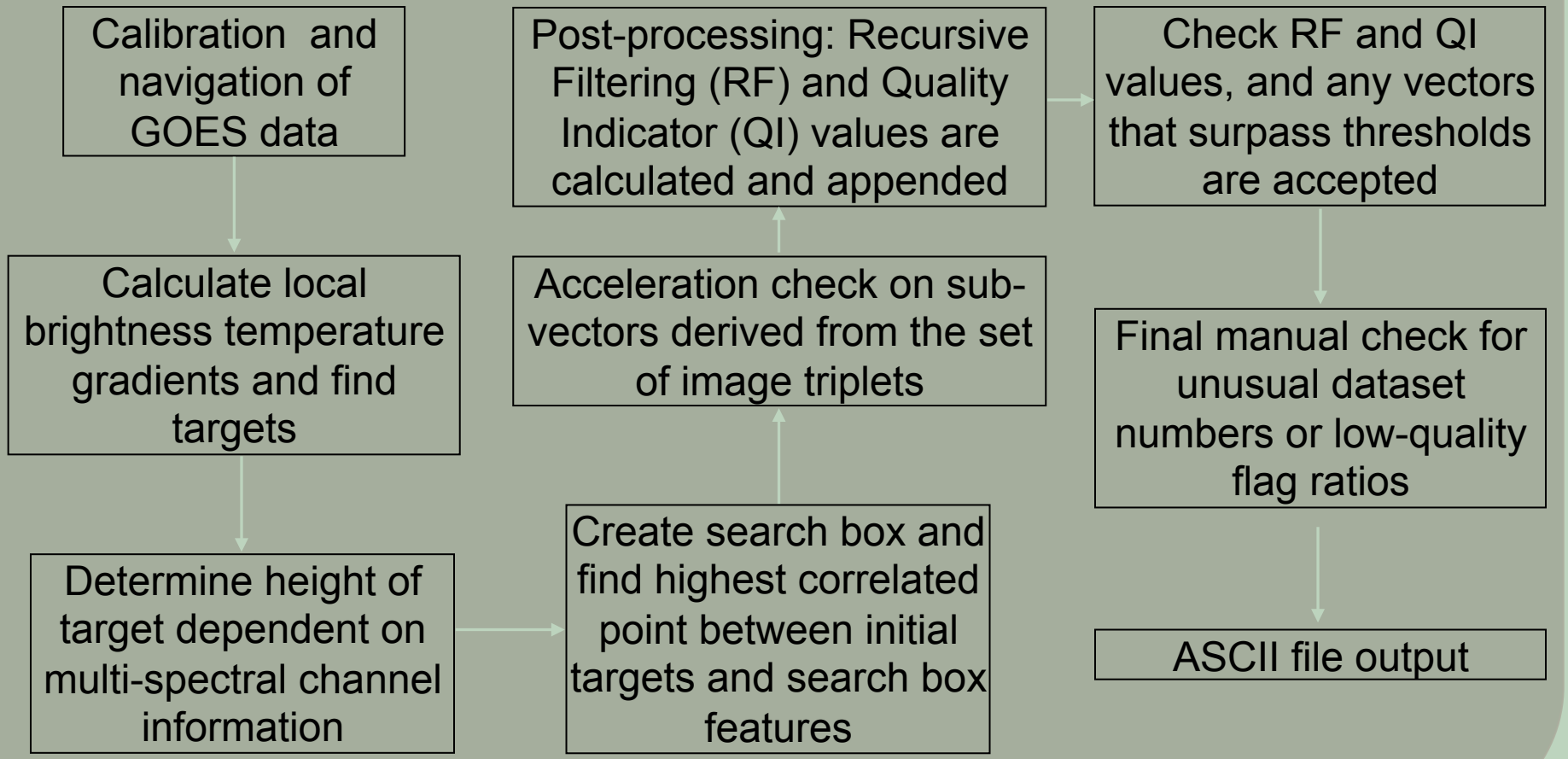
Processing -- Computing Cluster

- 400 compute cores
- 1 TB RAM
- 3.8 PB Storage
- Infiniband Interconnect
- Simple parallel or MPI Jobs



AMV Computational Software

- *Current Operational NESDIS/CIMSS Software*



AMV ASCII Output Fields

type	sat	day	hms	lat	lon	pre	spd	dir	rff	qiwf	qinf	zen	ch
WV	GOES12	20031026	2351	55.25	64.98	230	50.3	249	58.82	0.92	0.96	61	CO2
WVCS	GOES12	20031026	2347	51.51	70.91	262	77.0	227	50.00	0.90	0.96	59	HIST
IR	GOES12	20031026	2333	48.35	75.82	587	14.6	242	77.94	0.84	0.88	56	H2O
VIS	GOES12	20031026	2335	26.62	98.52	812	5.9	308	80.22	0.65	0.59	48	BASE
SWIR	GOES12	20031026	2335	55.96	74.25	737	6.6	255	81.52	0.99	0.99	64	WIN

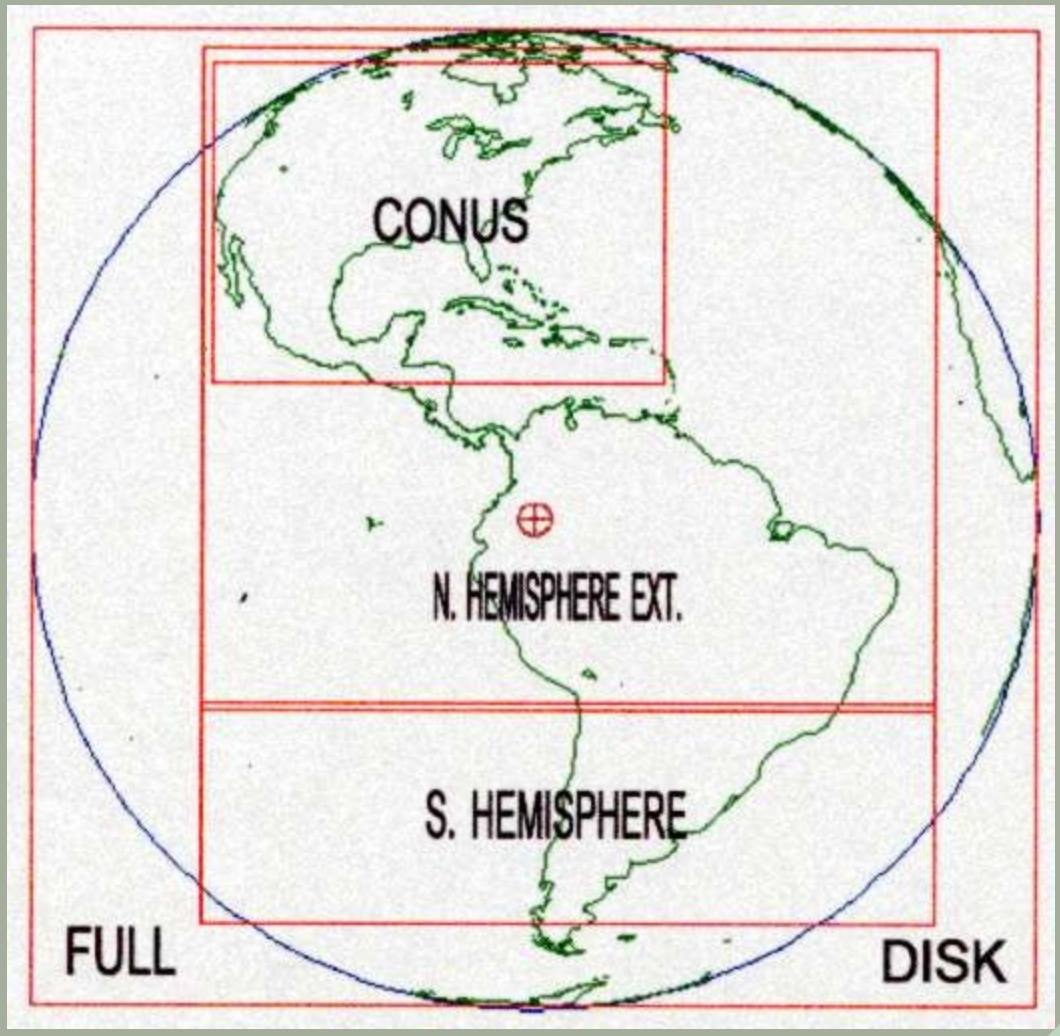
- Time (HMS) is satellite scan line time
- Longitude (LON) is positive west
- Height assignment pressure (PRE) is in hPa
- Speed (SPD) is in m/s
- RFF is the Recursive Filter quality Flag
- QIWF is the Quality Indicator With NWP Forecast
- QINF is the Quality Indicator No NWP Forecast
- ZEN is the local satellite zenith angle
- CH is the height assignment method

GOES East Scanning Metrics

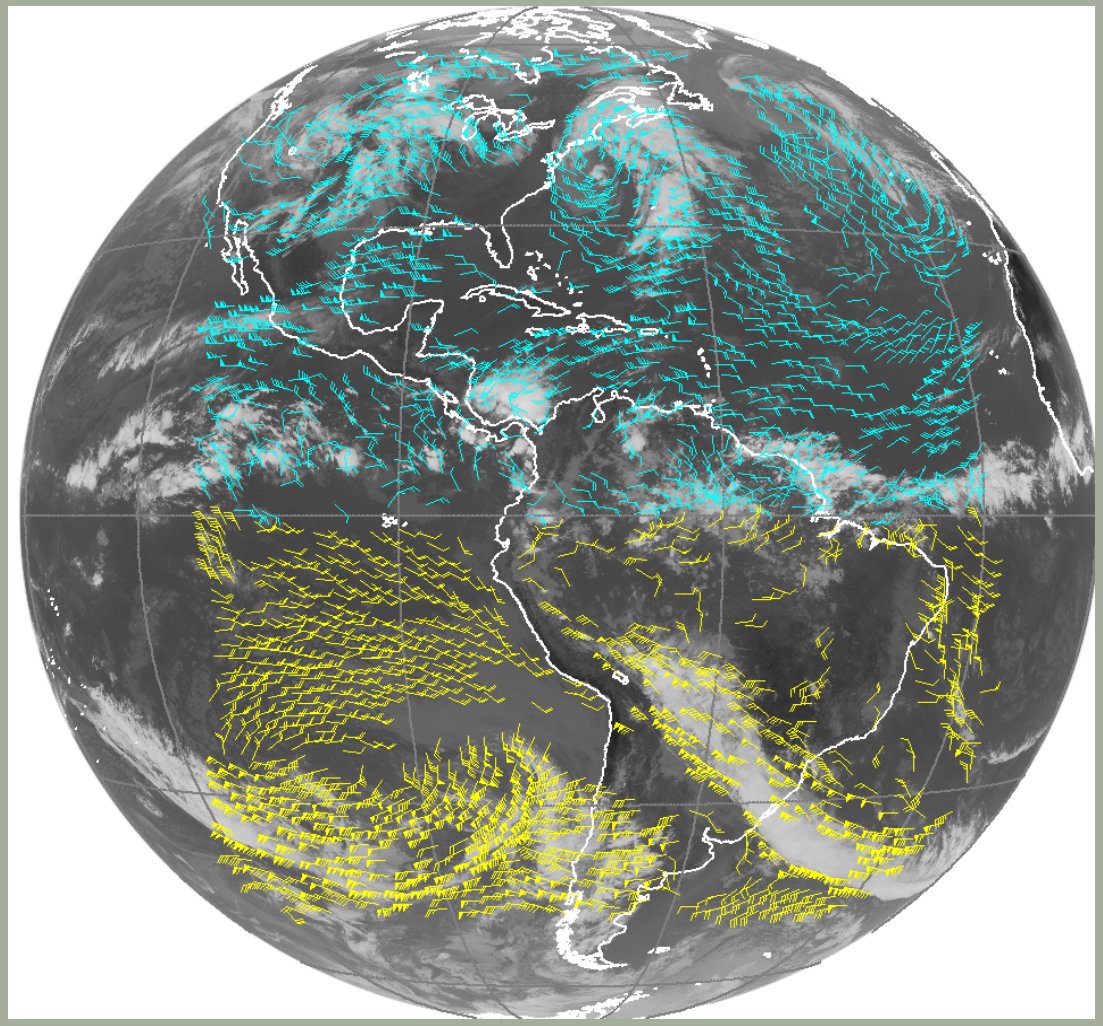
- NHEM AMVs:
- 15-minute image time steps over CONUS; 30-minute time steps elsewhere.

- SHEM AMVs:
- 30-minute time steps; NHEM+FD [0 – 20S]; FD+SHEM [20S – 50S]

- No RSO or SRSO used (rapid-scan modes)



GOES East Example AMVs



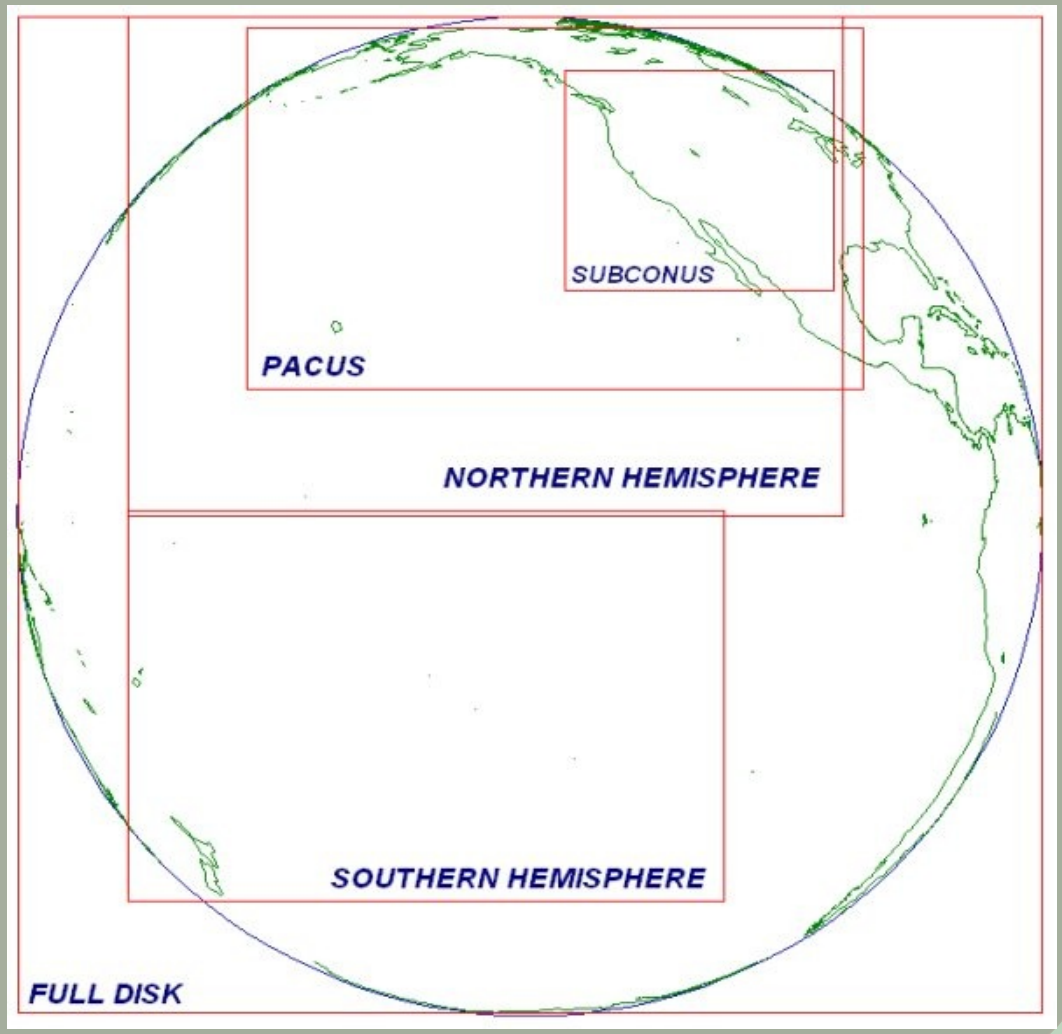
GOES-East
07 May 2005
1500 UTC

GOES West Scanning Metrics

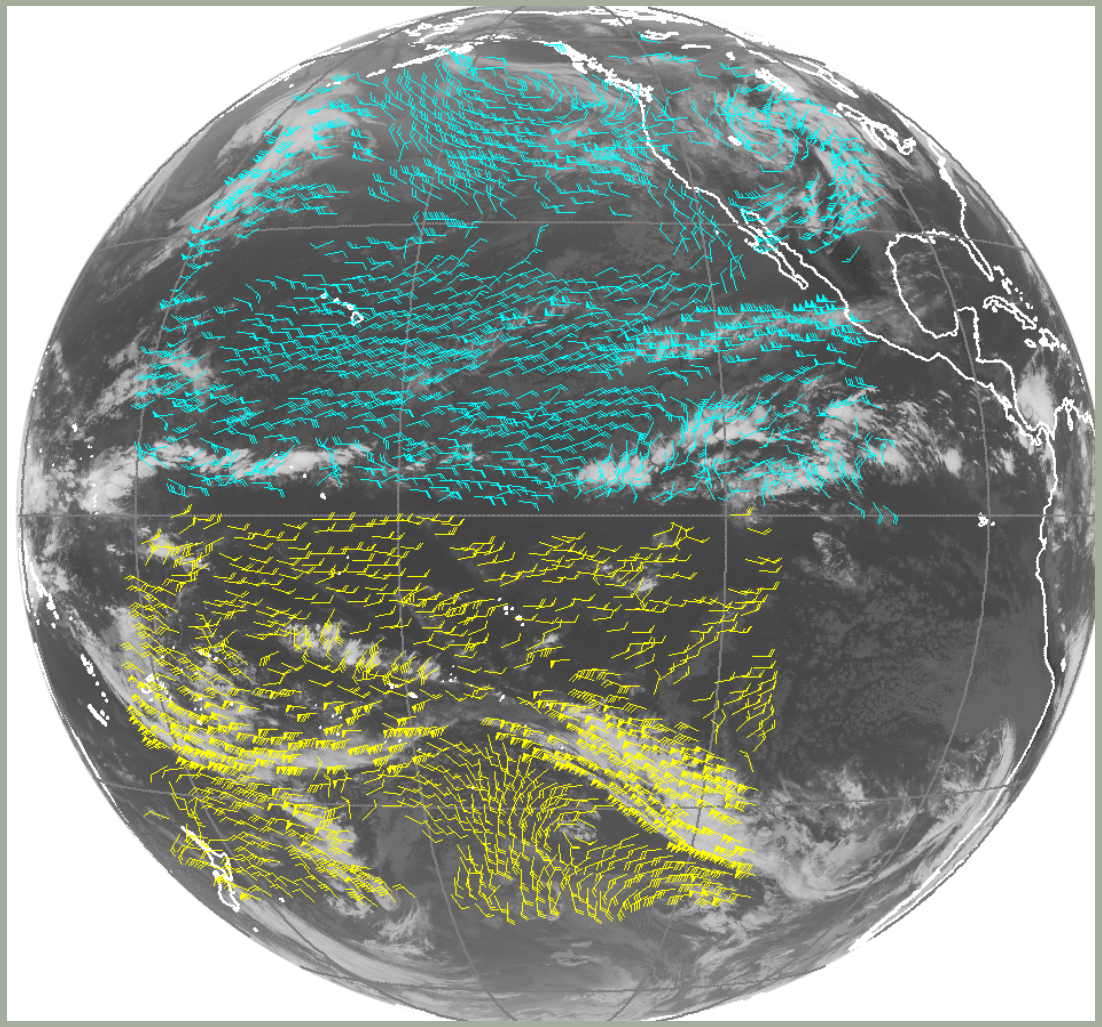
- NHEM AMVs:
- 15-minute image time steps over PACUS;
- 30-minute time steps elsewhere.

- SHEM AMVs:
- 30-minute time steps over SHEM sector.

- No RSO or SRSO used (rapid scans)



GOES WEST Example AMVs



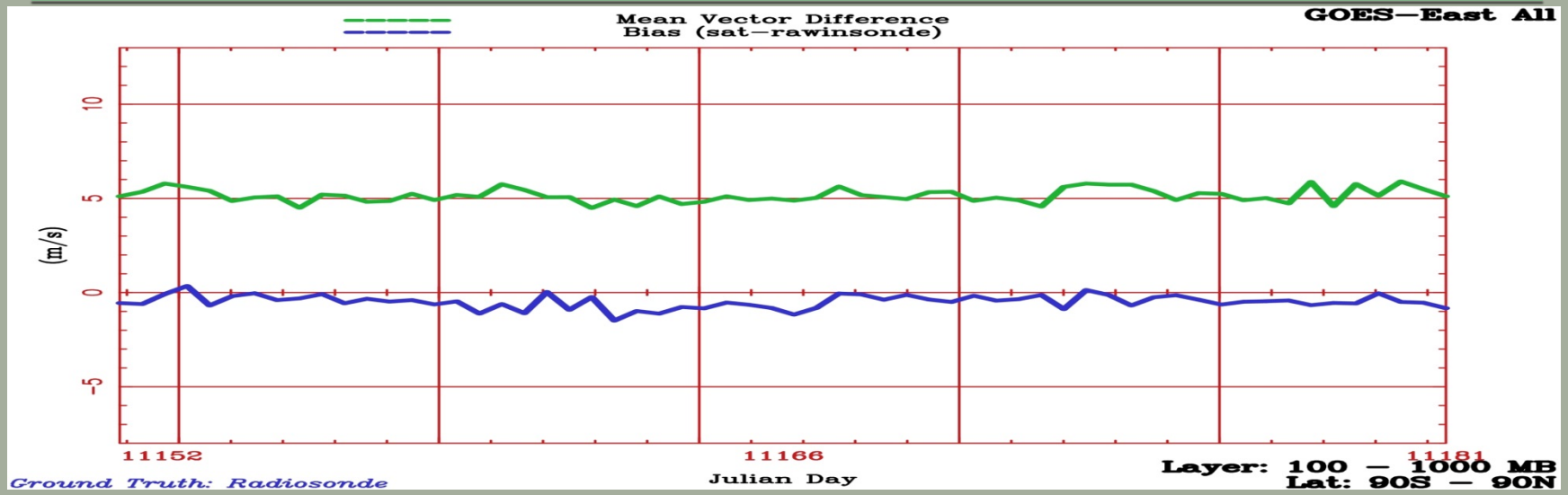
GOES-West
07 May 2005
1500 UTC

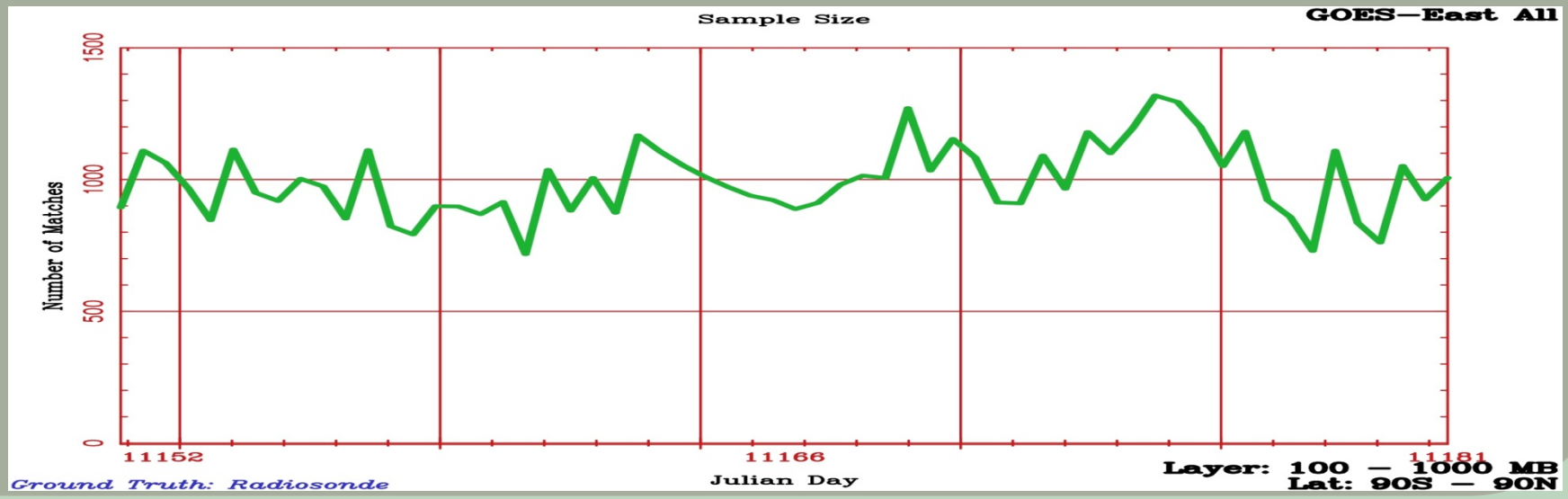
Project Quality Control Challenge

- 539,047 hourly AMV datasets in total
- 7,802,592,221 individual AMVs
- No way to manually inspect all of the datasets

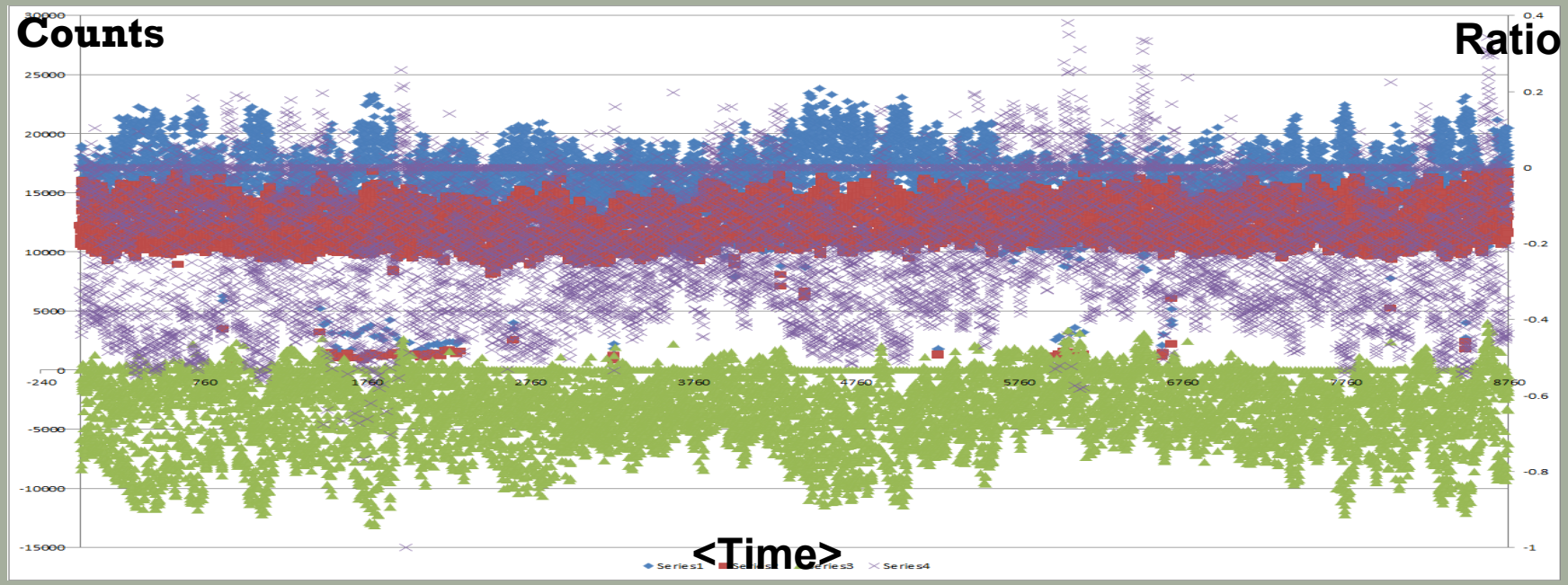
Collocated Rawinsonde Comparison Plots

Look for obvious anomalous signals/variability in graphs of monthly statistics.
Good initial filter, but not much help in GOES-WEST SH datasets.





Final Dataset Filtering



Isolate within each dataset:

Blue: Number of Good AMVs (passed internal QC)

Red: Number of AMVs that failed internal QC

Green: Failed minus Good Ratio

Purple: Ratio of (Failed QC minus Good AMV)/Good AMV

Dataset Retention Rule: Ratio (purple) below 0.3 and with at least 500 AMVs in a set

Processing Summary

- Continuous, hourly AMV datasets have been re-processed for GOES East/West from 1995 to mid-2013 using the current NESDIS operational algorithm
  - 6-month project completed in May 2014 by UW-SSEC
  - 539,047 AMV datasets generated.
  - Output ASCII text files now available for community access

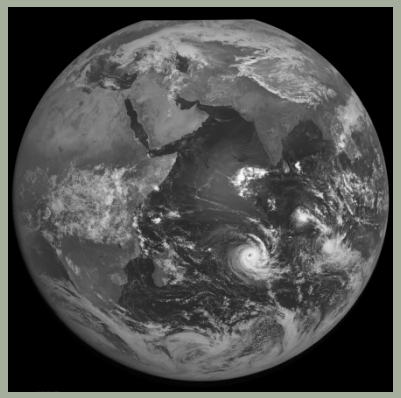
- *Phase 1a complete!*

- Future GOES AMV reprocessing plans (???>$$$)
  - Phase 1b: Reprocess GVAR dataset using the latest methods being developed for GOES-R (tracking and cloud height algorithms)

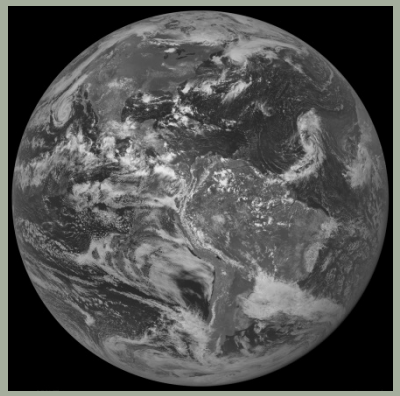
  - Phase 2: Extend the reprocessing to earlier U.S. satellites (1978 – 1994)
    - Will involve more efforts to correct early GOES sensor calibration and geolocation
    - Need to develop the cloud height products for the pre-GVAR era

GOES AMV Re-Processing—Phase 2?

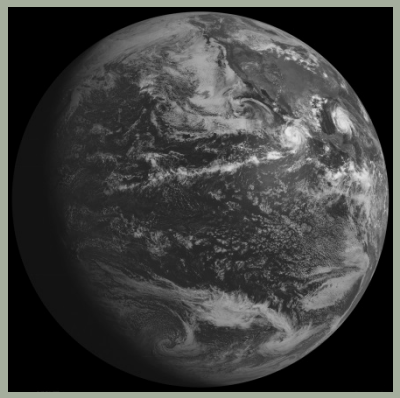
All on archive at UW-SSEC



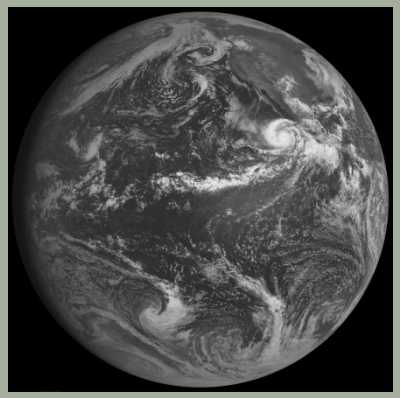
GOES-1



GOES-2

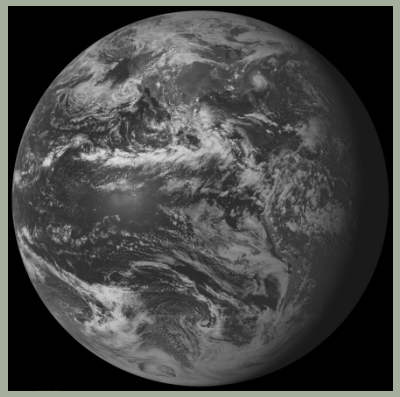


GOES-3

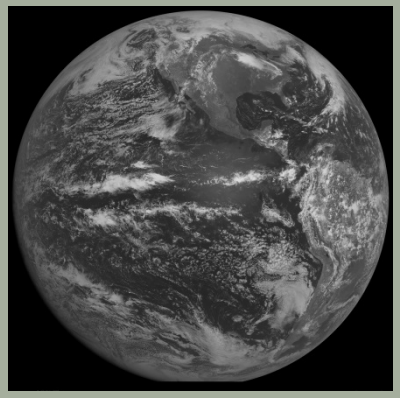


GOES-4

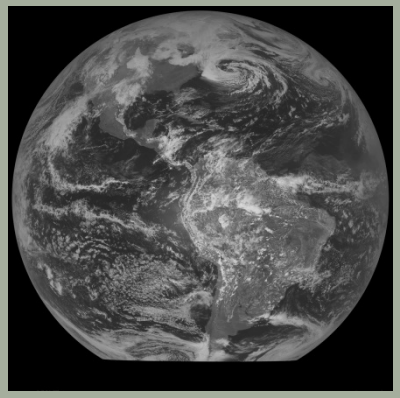
GOES-5



GOES-6



GOES-7



SMS 1/2

Questions?

The reprocessed GOES AMV tar/gzip'd files can be found at:

http://tropic.ssec.wisc.edu/archive/data/goes_reprocess/wind_files

I will be in the UW-Madison/SSEC booth from 1 – 2 pm today.

Backup Slides

Historical GOES East (Data)

	Satellite	Years of Service
Launched April 13, 1994	***GOES-08***	***1 January 1995 – 1 April 2003***
Launched April 25, 1997	***GOES-10***	***5 December 2007 – 17 December 2007***
Launched July 23, 2001	***GOES-12***	***1 April 2003 – 4 December 2007*** ***18 December 2007 – 14 December 2008*** ***5 January 2009 – 14 April 2010***
Launched May 24, 2006	***GOES-13***	***15 December 2008 – 4 January 2009*** ***14 April 2010 – 23 September 2012*** ***18 October 2012 – 22 May 2013*** ***10 June 2013 - present***
Launched June 27, 2009	***GOES-14***	***24 September 2012 – 17 October 2012*** ***23 May 2013 – 10 June 2013***

Historical GOES West (Data)

	Satellite	Years of Service
Launched May 23, 1995	*GOES-09*	*1 January 1996 – 21 July 1998*
Launched April 25, 1997	*GOES-10*	*21 July 1998 – 21 June 2006*
Launched May 3, 2000	*GOES-11*	*21 June 2006 – 6 December 2011*
Launched March 4, 2010	*GOES-15*	*6 December 2011 - present*

AMV Data Location

The tar/gzip'd file packages in:

http://tropic.ssec.wisc.edu/archive/data/goes_reprocess/wind_files

The file names are formatted [YYYYMM]-GOES-[E or W]-[NH or SH].tar.gz, where YYYY is the year, MM is the two digit month. For "E "or "W" use E for GOES-East or W for GOES-West. For "NH" or "SH" use NH for northern hemisphere or SH for southern hemisphere.

Use wget or curl for access. Future anonymous FTP?

wget http://tropic.ssec.wisc.edu/archive/data/goes_reprocess/wind_files/199501-GOES-E-NH.tar.gz

curl http://tropic.ssec.wisc.edu/archive/data/goes_reprocess/wind_files/199501-GOES-E-NH.tar.gz -O

Pre GVAR Data

Satellite	Potential Archive
GOES-01 [WestPac]	2 December 1978 – 1 December 1979 29 November 1982 – 31 May 1983 30 April 1984 – 3 February 1985
GOES-02 [EastUSA]	18 February 1978 – 26 January 1979
GOES-03 [WestUSA]	20 December 1978 – 4 March 1981
GOES-04 [WestUSA]	5 January 1981 – 25 November 1982
GOES-05 [EastUSA]	6 August 1981 – 29 July 1985
GOES-06 [WestUSA and PrimeUSA]	1 June 1983 – 2 April 1987 20 October 1987 – 21 January 1989
GOES-07 [East USA and PrimeUSA]	25 March 1987 – 9 January 1996
SMS I [EastUSA]	27 January 1979 – 19 April 1979
SMS II [EastUSA]	20 April 1979 – 5 August 1981

Assimilation of AMVs

- AMVs provided by CIMSS will use the features in place for the operational ECMWF NWP system (see talk by Niels Bormann for latest updates)

- Notable differences
  - AMV data reprocessed by CIMSS are ingested from text format (OPS: BUFR)
  - Then converted into ODB2 and archived on the Observation Feedback Archive (OFA), an ERA-CLIM development of ECMWF MARS (Archive)
  - Then retrieved from the OFA during reanalysis production and merged with other AMV data for assimilation
  - Equivalent AMV data from same instrument already available in the ECMWF archive will be blacklisted (to avoid using data with two different processing's)
  - Blacklist of the reprocessed AMV data can benefit from a prior look at the whole time-series of observations (from the OFA) to spot potentially problematic time periods

Slide courtesy of Paul Poli

GOES East NHEM Images

- GOES-E NH/CONUS triplets:
- 00:15, 00:45, 01:15 - 00:45, 01:02, 01:15
- 01:15, 01:45, 02:15 - 01:45, 02:02, 02:15
- 02:15, 02:45, 03:15 - 02:15, 02:32, 03:45
- 03:15, 03:45, 04:15 - 03:45, 04:02, 04:15
- 04:15, 04:45, 05:15 - 04:45, 05:02, 05:15
- 05:15, 05:45, 06:15 - 05:15, 05:32, 05:45
- 06:15, 06:45, 07:15 - 06:45, 07:02, 07:15
- 07:15, 07:45, 08:15 - 07:45, 08:02, 08:15
- 08:15, 08:45, 09:15 - 08:15, 08:32, 08:45
- 09:15, 09:45, 10:15 - 09:45, 10:02, 10:15
- 10:15, 10:45, 11:15 - 10:45, 11:02, 11:15
- 11:15, 11:45, 12:15 - 11:15, 11:32, 11:45
- 12:15, 12:45, 13:15 - 12:45, 13:02, 13:15
- 13:15, 13:45, 14:15 - 13:45, 14:02, 14:15
- 14:15, 14:45, 15:15 - 14:15, 14:32, 14:45
- 15:15, 15:45, 16:15 - 15:45, 16:02, 16:15
- 16:15, 16:45, 17:15 - 16:45, 17:02, 17:15
- 17:15, 17:45, 18:15 - 17:15, 17:32, 17:45
- 18:15, 18:45, 19:15 - 18:45, 19:02, 19:15
- 19:15, 19:45, 20:15 - 19:45, 20:02, 20:15
- 20:15, 20:45, 21:15 - 20:15, 20:32, 20:45
- 21:15, 21:45, 22:15 - 21:45, 22:02, 22:15
- 22:15, 22:45, 23:15 - 22:45, 23:02, 23:15
- 23:15, 23:45, 00:15 - 23:15, 23:32, 23:45

GOES East SHEM Images

- GOES-E SH (0-20S/20S-50S) triplets:
- 00:15, 00:45, 01:15 - 00:39(G-13 only), 01:09, 01:39
- 01:15, 01:45, 02:15 - 01:39, 02:09, 02:39
- 02:15, 02:45, 03:15 - 02:39, 02:45, 03:39
- 03:15, 03:45, 04:15 - 03:39, 04:09, 04:39
- 04:15, 04:45, 05:15 - 04:39, 05:09, 05:39
- 05:15, 05:45, 06:15 - 05:39, 05:45, 06:39(G-12/13, G-8 2001 only)
- 06:15, 06:45, 07:15 - 06:39(G-12/13, G-8 2001 only), 07:09, 07:39
- 07:15, 07:45, 08:15 - 07:39, 08:09, 08:39
- 08:15, 08:45, 09:15 - 08:39, 08:45, 09:39
- 09:15, 09:45, 10:15 - 09:39, 10:09, 10:39
- 10:15, 10:45, 11:15 - 10:39, 11:09, 11:39
- 11:15, 11:45, 12:15 - 11:39, 11:45, 12:39(G-13 only)
- 12:15, 12:45, 13:15 - 12:39(G-13 only), 13:09, 13:39
- 13:15, 13:45, 14:15 - 13:39, 14:09, 14:39
- 14:15, 14:45, 15:15 - 14:39, 14:45, 15:39(not G-13)
- 15:15, 15:45, 16:15 - 15:39(not G-13), 16:09, 16:39
- 16:15, 16:45, 17:15 - 16:39, 17:09, 17:39
- 17:15, 17:45, 18:15 - 17:39, 17:45, 18:39(G-13 only)
- 18:15, 18:45, 19:15 - 18:39(G-13 only), 19:09, 19:39
- 19:15, 19:45, 20:15 - 19:39, 20:09, 20:39
- 20:15, 20:45, 21:15 - 20:39, 20:45, 21:39
- 21:15, 21:45, 22:15 - 21:39, 22:09, 22:39
- 22:15, 22:45, 23:15 - 22:39, 23:09, 23:39
- 23:15, 23:45, 00:15 - 23:39, 23:45, 00:39(G-13 only)

GOES West NHEM Images

- GOES-W NH/CONUS triplets GOES-15 (GOES-9/10/11):
- 23:30, 00:00, 00:30 - 23:30, 23:45, 00:00
- 00:30, 01:00, 01:30 - 01:00, 01:15, 01:30 (00:45, 01:00, 01:15 could use for GOES-9/10/11)
- 01:30, 02:00, 02:30 - 01:45, 02:00, 02:15 (02:00, 02:15, 02:30 must use for GOES-9)
- 02:30, 03:00, 03:30 - 02:30, 02:45, 03:00
- 03:30, 04:00, 04:30 - 03:45, 04:00, 04:15 (04:00, 04:15, 04:30 must use for GOES-9/10/11)
- 04:30, 05:00, 05:30 - 04:45, 05:00, 05:15
- 05:30, 06:00, 06:30 - 05:30. 05:45, 06:00
- 06:30, 07:00, 07:30 - 06:45, 07:00, 07:15
- 07:30, 08:00, 08:30 - 07:45, 08:00, 08:15 (08:00, 08:15, 08:30 must use for GOES-9)
- 08:30, 09:00, 09:30 - 08:30, 08:45, 09:00
- 09:30, 10:00, 10:30 - 09:45, 10:00, 10:15 (10:00, 10:15, 10:30 GOES-9)
- 10:30, 11:00, 11:30 - 10:45, 11:00, 11:15
- 11:30, 12:00, 12:30 - 11:30, 11:45, 12:00
- 12:30, 13:00, 13:30 - 12:45, 13:00, 13:15
- 13:30, 14:00, 14:30 - 13:45, 14:00, 14:15 (14:00, 14:15, 14:30 must use for GOES-9)
- 14:30, 15:00, 15:30 - 14:30, 14:45, 15:00
- 15:30, 16:00, 16:30 - 15:45, 16:00, 16:15 (16:00, 16:15, 16:30 must use for GOES-9/10/11)
- 16:30, 17:00, 17:30 - 17:00. 17:15, 17:30 (16:45, 17:00, 17:15 could use for GOES-9/10/11)
- 17:30, 18:00, 18:30 - 17:30, 17:45, 18:00
- 18:30, 19:00, 19:30 - 18:45, 19:00, 19:15
- 19:30, 20:00, 20:30 - 19:45, 20:00, 20:15 (20:00, 20:15, 20:30 must use for GOES-9)
- 20:30, 21:00, 21:30 - None (20:30, 20:45, 21:00 must use for GOES-9/10/11)
- 21:30, 22:00, 22:30 - 21:45, 22:00, 22:15 (22:00, 22:15, 22:30 must use for GOES-9/10/11)
- 22:30, 23:00, 23:30 - 22:45, 23:00, 23:15

GOES West SHEM Images

- GOES-W SH triplets GOES-W:
- 23:22, 23:52, 00:00
- 00:00, 00:52, 01:22
- 01:22, 01:52, 02:22 (unavailable for GOES-9)
- 02:22, 02:52, 03:00
- 03:00, 03:52, 04:22 (unavailable for GOES-10/11)
- 04:22, 04:52, 05:22
- 05:22, 05:52, 06:00
- 06:00, 06:52, 07:22
- 07:22, 07:52, 08:22 (unavailable for GOES-9)
- 08:22, 08:52, 09:00
- 09:00, 09:52, 10:22
- 10:22, 10:52, 11:22
- 11:22, 11:52, 12:00
- 12:00, 12:52, 13:22
- 13:22, 13:52, 14:22 (unavailable for GOES-9)
- 14:22, 14:53, 15:00
- 15:00, 15:52, 16:22 (unavailable for GOES-10/11)
- 16:22, 16:52, 17:22
- 17:22, 17:52, 18:00
- 18:00, 18:52, 19:22
- 19:22, 19:52, 20:22 (unavailable for GOEs-9)
- 20:22, 20:52, 21:00 (unavailable for GOES-15)
- 21:00, 21:52, 22:22 (unavailable for GOES-10/11)
- 22:22, 22:52, 23:22

Vis t<9 or t>15
Swir t> 3 and t<18